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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
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09/255,856 02/23/99 IWASAKI

T 501.39631X00

EXAMINER

MM91/0706

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& KRAUS
1300 NORTH SEVENTEENTH STREET
SUITE 1800
ARLINGTON VA 22209

SMOOT, S

ART UNIT

PAPER NUMBER

2813

DATE MAILED:

07/06/01

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary

Application No.

09/255,856

Applicant(s)

IWASAKI ET AL.

Examiner

Stephen W. Smoot

Art Unit

2813

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 11 May 2001.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-6, 9-20, 22-25 and 27-31 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 1, 2, 5, 6, 9-20, 22-25 and 27-29 is/are allowed.
- 6) ☒ Claim(s) 3, 30 and 31 is/are rejected.
- 7) ☒ Claim(s) 4 is/are objected to.
- 8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are objected to by the Examiner.
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

- 15) ☒ Notice of References Cited (PTO-892)
- 16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 17) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 18) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 19) ☐ Notice of Informal Patent Application (PTO-152)
- 20) ☐ Other: _____

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 11 May 2001 has been entered.

Claim Objections

2. Claim 4 is objected to because of the following informalities:

In claim 4, line 6, insert --a-- before "rhodium"; and

In claim 4, line 9, insert --and-- after "interconnect".

Appropriate correction is required.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –
(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

4. Claims 30-31 are rejected under 35 U.S.C. 102(e) as being anticipated by Schacham-Diamand et al.

Referring to Fig. 13 of Schacham-Diamand et al., an embodiment whereby copper is deposited in trench regions of a semiconductor structure (see column 8, lines 58-61) is disclosed with the following features: (a) copper interconnects (33) in contact with a catalytic seed layer; (b) the catalytic seed layer (18a) can be comprised of platinum or rhodium (see column 7, lines 28-31); (c) a diffusion barrier layer (17a) that can be comprised of titanium nitride, tantalum or tungsten (see column 6, lines 35-37 and column 7, lines 26-28); and (d) the catalytic seed layer and diffusion barrier layer are in contact (see column 9, lines 14-20 and column 6, lines 45-47). These are the limitations set forth in the independent claims 30-31 of the applicant's invention.

Response to Arguments: Applicant's arguments filed 11 May 2001 (Paper no. 14) have been fully considered but they are not persuasive.

Regarding the primary constituent element limitation of claims 30-31 (see Paper No. 14, page 14, lines 5-11), Schacham-Diamand et al. clearly indicate that platinum or rhodium as well as other metals can be used as an alternative material for the copper seed layer (see column 7, lines 23-24, 29-32). In such alternative embodiments, the platinum or the rhodium would be the sole constituent. Regarding process limitations of product-by-process claims, applicant's argument (see Paper no. 14, page 25, last paragraph) is not persuasive because *In re Luck* specifies that the process limitations must distinguish the product over the prior art.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hussein et al. in view of the IBM Technical Disclosure Bulletin.

Referring to Fig. 3, Hussein et al. disclose the following limitations set forth in claim 3: a semiconductor substrate (1), a diffusion barrier (5), and interconnect layers (7, 30) that can be copper (see column 3, lines 50-53). Layer 7 is a liner layer that is applied to the barrier layer 5 (see column 3, lines 55-57) and therefore layers 5 and 7

"neighbor " each other. However, Hussein et al. do not disclose ruthenium as a diffusion barrier material. The IBM Technical Disclosure Bulletin does teach that ruthenium (as well as rhenium, osmium, and iridium) is an exceptional barrier against the diffusion of copper (see first sentence of final paragraph). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the teachings of the IBM Technical Disclosure Bulletin with those of Hussein et al. and use ruthenium as a diffusion barrier material. Hussein et al. recognize that copper diffusion into silicon and, also into any surrounding dielectric material, can result in defective circuitry (see column 1, lines 55-57).

Response to Arguments: Applicant's arguments filed 11 May 2001 (Paper no. 14) have been fully considered but they are not persuasive.

Regarding the primary constituent element limitation of claims 3 (see Paper No. 14, page 14, lines 5-11), the IBM Technical Bulletin clearly indicates that ruthenium, osmium, or iridium diffusion barrier layers would be the sole constituent. Regarding applicant's argument that there is no suggestion to combine Hussein et al. and the IBM Technical Disclosure Bulletin (see Paper No. 14, page 21, lines 19-24), please note the first sentence of the final paragraph of the IBM Technical Disclosure Bulletin where it is clearly indicated that ruthenium is an excellent barrier against the diffusion of copper and its alloys. Regarding process limitations of product-by-process claims, applicant's argument (see Paper no. 14, page 25, last paragraph) is not persuasive because *In re Luck* specifies that the process limitations must distinguish the product over the prior art.

Allowable Subject Matter

7. Claims 1-2, 5-6, 9-20, 22-25, 27-29 are allowed.
8. Claim 4 would be allowable if rewritten or amended to overcome the objections set forth in this Office action.
9. The following is a statement of reasons for the indication of allowable subject matter: The independent claims 1-2, 4, 6, 9, 27 are or would be allowable because the prior art of record does not teach or suggest that neighboring layers of rhodium, ruthenium, iridium, osmium, or platinum prevent the formation of voids due to the electromigration of copper. Claim 5 is allowable because the prior art of record does not teach or suggest an interconnect structure comprising plugs with ruthenium as the primary constituent element.

Conclusion

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Green et al. suggest the use of ruthenium as an interconnection material because of its high electromigration resistance.

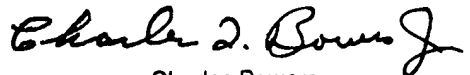
Art Unit: 2813

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen W. Smoot whose telephone number is 703-305-0168. The examiner can normally be reached on M-F (8:00am to 4:30pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Charles Bowers can be reached on 703-308-2417. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

SWS
June 28, 2001



Charles Bowers
Supervisory Patent Examiner
Technology Center 2800